MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

FOURTH YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EES 411: CONTROL ENGINEERING II

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer Question one and any other two questions.

2. Mobile phones are not allowed in the examination room.

3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) i. In the context of digital control system explain the sampling process. (2marks)

   ii. Differentiate between the pulse and impulse signals (3marks)

b) Explain how the s-plane is mapped into 2-plane. Illustrate your answer with the basic equations and diagrams (6marks)

c) Determine the 2-transform of $f_{(t)}$ – sin ut for t≥ 0 (5marks)

d) Sketch the operating block diagram of a digital PID and deduct its transfer function assuming that the input and output an E(2) and M(2) respectively (5marks)

e) With schematic diagrams explain the principles of operation of the:

   i. Pneumatic controller cactuator

   ii. Hydraulic controller (achator) (6marks)

f) For the computer based controller in digital control systems, explain a "mainframe" computer (3marks)

SECTION TWO: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) Sketch the schematic representation of a single-joint robot arm, with only one joint. Assuming that the actuator is that of an armature controlled dc servo motor, deduce the operating block diagram considering that the arm is connected to the motor through gears with a ratio of $n = \dfrac{R_1}{R_2}$

b) Sketch the three elements of linear rotational systems. Define each of them with a mathematical model. (10marks)

c) With the aid of a diagram depicting a thermal system, explain its operation and show that:

   _____

   Where T is the temperature of the liquid flowing out of the tank, Ta is ambient air temperature outside the tank while R is the thermal resistance. (5marks)

QUESTION THREE (20 MARKS)

a) With the aid of a schematic digital control system, describe how each of the controllers can be implemented using a digital computer. (8marks)

b) Given that $e(k) = e^{-akt}$, find it's 2- transform. (5marks)

c) The sampling operation causes a loss of information and therefore an effort to reduce this loss of information a data reconstruction device is required. Describe this device and use relevant schematic diagrams and signals (represented graphically) (7marks)

QUESTION FOUR (20 MARKS)

a) An open loop transfer function G(s)=$\frac{10}{5(5+1)}$ is connected in series with a zero order-hold modifier. Determine its steady state error assuming a UNIT step input to the system.

b) Find the inverse 2-transform of the system transfer function expressed by the following equation: $G_{(2)} = \frac{42^2 - 2Z}{2^3 - 5z^2 - 8_2 - 4}$

c) The feed forward transfer function (G,ss) of a system is connected in series with a ZERO-ORDER hold. If Gss is expressed as next, obtain the sampled data transfer function. $G_{(2)}$ if the sampling time T is given as half a second. $Gss = \frac{5+2}{5+1}$ (Use partial fraction method) (8marks)